

THE CLIMATE OF EAST GIPPSLAND

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Abstract

In this analysis of the climate of East Gippsland, the elements of rainfall, hail, snow, temperature and fog are discussed and related to the synoptic features which affect the area.

The most significant feature is the 'east coast depression', which can bring heavy rain to the area and cause flooding. The region has one of the more dependable rainfalls in Victoria, although drought is by no means unknown.

The air temperature can vary from below freezing point in a winter frost, to over 100°F in a summer heat wave. Mean temperatures are not very different from those elsewhere in southern Victoria, but with northerly winds in winter, parts of the region may experience the highest day-time temperatures in the State.

The incidence of fog in the lower river valleys is usually confined to winter mornings, but sea-fog occurs in summer and may affect the coast.

Introduction

The climate of East Gippsland is different in many respects from that of the remainder of Victoria. It is subject to the influence of vigorous depressions off the N.S.W. coast, and incursions of warm, moist subtropical air from the Tasman Sea, and has a climate more akin to that of coastal N.S.W. Rainfall in the area can be very heavy, resulting in rapid flooding of coastal streams. Sea fog is not uncommon in summer, and may affect the coastline, while day-time temperatures in winter may be the highest in Victoria.

Observing Stations

The area has not been well served with climatological stations in the past, although the number has been increased in recent years. At the oldest station, Gabo Island, 100 years of records are available, but since this station is situated on an island off the coast, the records are only typical of the area close to the coast. The station at Orbost has been in existence for over 25 years and those at Cann River and Nowa Nowa for over 15 years, although the records at these latter two are somewhat incomplete.

Stations have been opened in the past five years at Lakes Entrance, Cape Everard and Bendoe, but the period of record is too short for mean values to be calculated. Bendoe, at an elevation of 2,750 ft, is the only station located in the highlands of the area.

There are over fifty rainfall stations, of which twelve have more than fifty years of record. The rainfall stations are situated in the settled parts along roads and river valleys, and thus little is known of the rainfall in the more mountainous country.

Synoptic Features

The predominating circulation pattern which affects Victoria is an irregular succession of depressions and anticyclones. Although these systems generally move

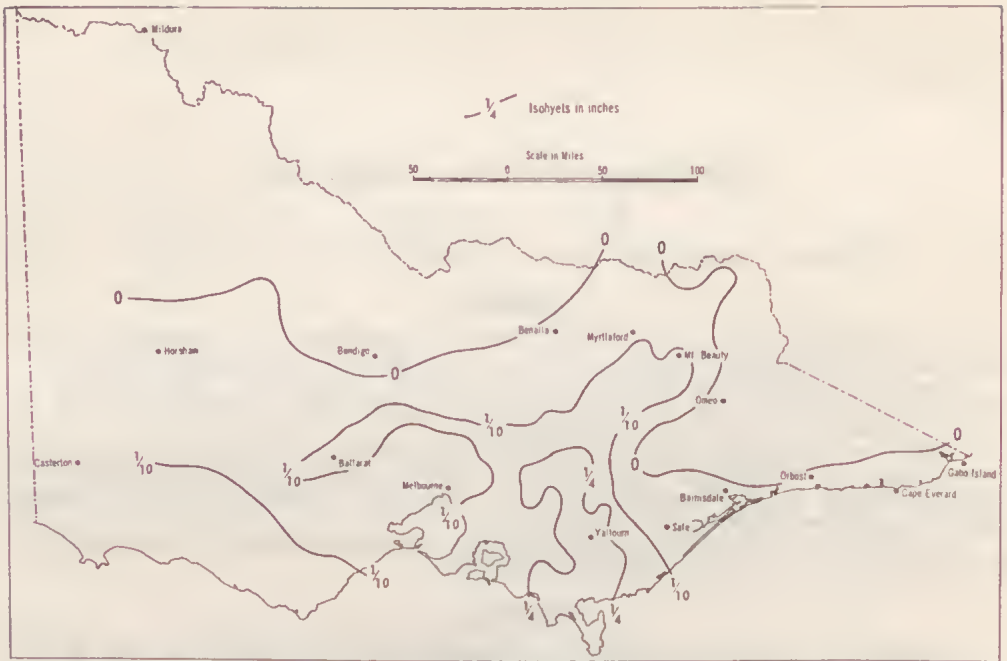


FIG. 1—Rainfall distribution after passage of cold front. Rainfall for 24 hours ended 9 a.m. 11 May 1966.

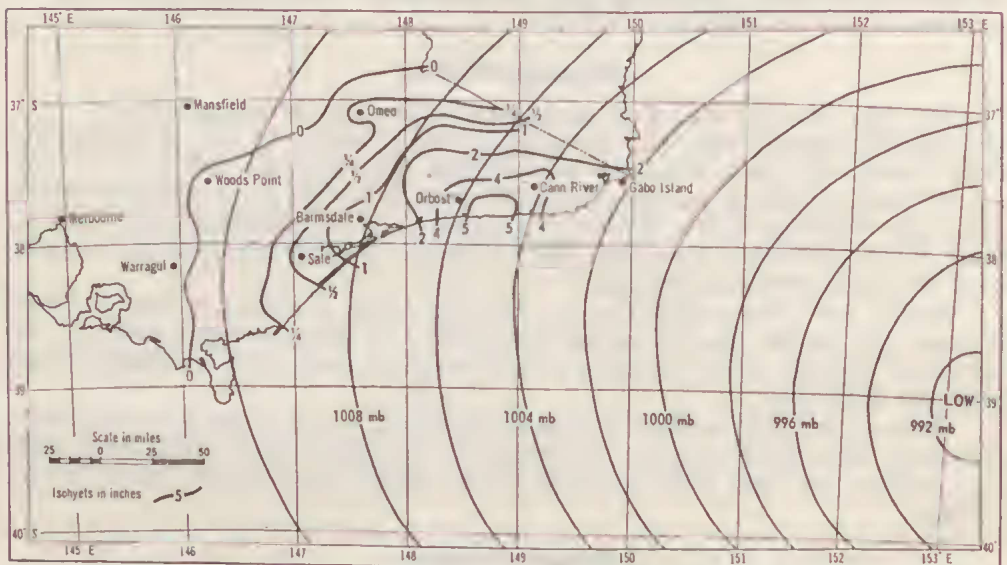


FIG. 2—Surface Isobaric pattern 6 a.m. 21 February 1966 and Rainfall for 48 hours ended 9 a.m. 21 February 1966.

from W. to E., this is not always the case. Systems can develop or degenerate in the area. Their speed of movement can vary considerably, and they can remain quasi-stationary for even a week or more at a time.

A common rain-producing situation for most of southern Victoria is the passage of a depression to the S. of Tasmania, while cold fronts cross Victoria. However, very little rain falls in East Gippsland with this pattern. Fig. 1 shows a typical rainfall distribution.

East Gippsland receives the bulk of its rainfall from depressions centred off the E. coast of Australia. These may have passed through Bass Strait and intensified near Gabo Island, but more commonly, they have developed off the coast of N.S.W. and moved southwards. When the centre is just SE. of Gabo Island, a vigorous southerly airstream is brought to East Gippsland. This air has originated in the Tasman Sea, is warm and moist, and produces very heavy rainfall over most of East Gippsland and particularly between Orbost and Cann River. (See Fig. 2.)

There is no seasonal trend in the occurrence of east coast depressions. Karelsky (1965) has found the number of cyclonic centres in 5° squares of latitude and longitude over the 12 years 1952-1963. (Table 1.)

TABLE 1
NUMBER OF CYCLONIC CENTRES IN 12 YEARS 1952-1963, BETWEEN 35°S AND 40°S

Month	Between Longitudes	
	145°-150°E	150°-155°E
January	9	18
February	2	13
March	3	11
April	7	11
May	12	25
June	11	3
July	10	21
August	8	23
September	14	23
October	10	17
November	7	18
December	8	23
Year	101	206

Not all of these depressions produce heavy rainfall in East Gippsland, as the position of the centre, the intensity, and conditions in the upper atmosphere are all factors determining the amount of rain which falls.

Rainfall

The average annual rainfall over the area is shown in Fig. 3, where the influence of the Snowy River valley can be seen. The driest part of the whole area is found along the valleys of the Snowy and Deddick rivers near the N.S.W. border, where average rainfall is between 25 and 30 inches per year. The mountainous area near Mt. Cobberas, to the W. of these valleys, could be expected to have much higher annual rainfall, probably in excess of 50 inches. The annual average exceeds 40 inches between Cabbage Tree and Cann River and north-

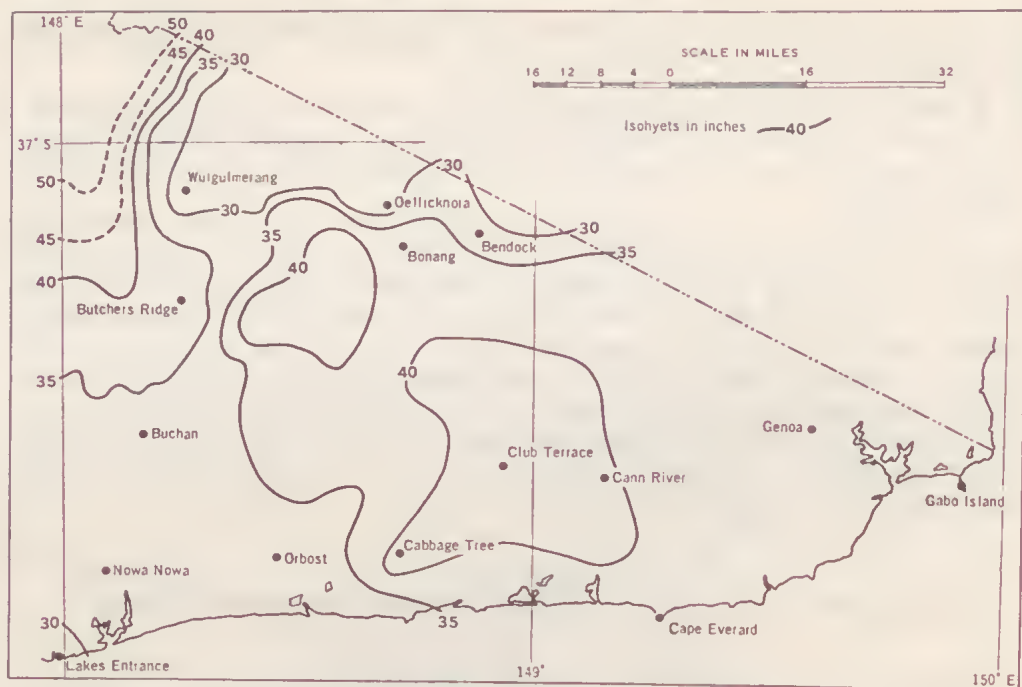


FIG. 3—Average Annual Rainfall—Eastern Gippsland.

wards, and probably also on the higher country between the Brodribb and Snowy rivers.

The variation in the average rainfall through the year is not great, and at the great majority of places, the average rainfall exceeds two inches in each month of the year. There is a slight seasonal maximum in summer in the N. of the area, and a slight winter maximum in the E. This is indicated for two typical locations in Table 2.

TABLE 2
AVERAGE RAINFALL (in inches)

	April-September	October-March
Wulgulmerang	11·41	14·19
Genoa	19·56	17·59

Depending as it does on the incidence of east coast depressions, the actual rainfall can vary considerably from one month to the next. For example, in 1906, Orbest received 0·13" in February, 10·00" in March, and 0·92" in April. The average rainfall is calculated from a small number of high monthly falls and a larger number of low monthly falls.

To illustrate this, the mean and median of monthly rainfall over 53 years in East Gippsland is shown in Table 3. The median is the rainfall which is not exceeded in 50% of occasions. (This district rainfall is the average of the rainfall at the twelve stations: Bairnsdale, Bendoc Park, Bonang, Bruthen, Buchan, Butcher's Ridge, Dargo, Dellicknora, Ensay, Gabo Island, Lakes Entrance and Orbest.

TABLE 3
DISTRICT RAINFALL (inches): EAST GIPPSLAND 1913-65

	Median	Mean
January	1.80	2.47
February	2.05	2.19
March	1.88	2.46
April	2.11	2.46
May	1.92	2.51
June	1.99	2.62
July	1.86	2.40
August	2.05	2.25
September	1.93	2.43
October	2.81	2.94
November	2.36	2.73
December	2.60	2.74

Although some of these places are outside the area under consideration, they form a homogeneous rainfall district). In all months the median is less than the average, and in some by a considerable margin.

However on a seasonal basis, the difference between median and mean is very small except in autumn (Table 4).

The average annual rainfall for the district is 30.20 inches, and the annual rainfall shows less variation from year to year than many other districts of Victoria. The standard deviation of 5.25 inches is 17.4% of the average, compared to a standard deviation of 13.4% of the average in the Western Plains and 28.3% in the northern Mallee.

TABLE 4
DISTRICT RAINFALL (inches): EAST GIPPSLAND 1913-65

	Median	Mean
Summer	7.41	7.39
Autumn	6.80	7.42
Winter	7.25	7.27
Spring	8.02	8.10

At stations with a record of at least fifty years, the annual rainfall has varied from just less than 20 inches to over 50 inches, while 70 inches was recorded in one year at Butcher's Ridge.

Effective Rainfall and Drought

Effective rainfall is defined as the amount of rain necessary to start germination and to maintain plant growth above the wilting point, and has been related to evaporation by Prescott in the formula

$$P = 0.54E^{0.7}$$

where P is the effective rainfall and E the evaporation.

Because of the lack of evaporation-recording stations in the area, evaporation has been estimated from the saturation deficit at 9 a.m., and the effective rainfall then calculated.

The chances of receiving rainfall equal to or exceeding the effective amounts for each month of the year have been calculated for a number of places in the area,

and expressed as a percentage frequency of occurrence. This frequency ranges from over 60% in summer to over 90% in winter. Thus there is an almost continuous growing season, and in the highlands growth is limited by low winter temperature rather than by lack of moisture.

At Orbost, two consecutive months of non-effective rainfall may be expected in about 50% of years, and three consecutive months of non-effective rainfall in 10% of years. There has been one occasion of four, and one of five, consecutive months of non-effective rainfall. In most cases, these periods occur in the warmer months of the year.

The definition of drought is extremely difficult as the concept cannot be divorced from the use to which water is put. (Gibbs and Maher 1966).

Foley (1957) used rainfall deficiencies to develop an index of drought and to show the severity and duration of past droughts. The following list of the more intense droughts is based on the rainfall at Sale, Bairnsdale, Maffra, Rosedale and Warragul. Although these are outside the area under consideration, three of the stations have a sequence similar to East Gippsland, of dry and wet years.

YEARS	APPROXIMATE DURATION	MONTHS
1882	9 months	Jan.-Sept.
1883-84	10 months	Dec.-Sept.
1885	8 months	May-Dec.
1888	10 months	Apr.-Nov.
1894-95	13 months	Nov.-Nov.
1897-99	19 months	
1908	5 months	Jan.-May
1909-10	11 months	Oct.-Aug.
1911-12	11 months	Aug.-June
1913-16	3 years 2 months	
1922-23	6 months	Nov.-Apr.
1925-26	6 months	Sept.-Feb.
1926-27	10 months	Sept.-June
1932-33	9 months	Sept.-May
1938-39	6 months	Aug.-Jan.
1939-40	11 months	Dec.-Oct.
1943-44	6 months	Oct.-Mar.
1944	6 months	June-Nov.

After a break of twenty years, drought was again experienced in East Gippsland from late in 1964 to the spring of 1965.

As is usually found with the incidence of drought, there is no regularity in its occurrence, and its prediction by statistical means proves impossible.

Rainfall Intensity and Floods

A vigorous east coast depression can cause a large amount of rain to fall in a short space of time. The frequency of 24 hour falls in excess of 3 inches is greater in East Gippsland than in other parts of Victoria. (Table 5).

The most frequent occurrence of this heavy rainfall is in the lower country from Nowa Nowa to Cann River, which receives the full force of a surface depression off the coast. This rainfall frequently causes rapid rises in the short coastal streams such as the Brodribb, the Benm and the Cann. Heavy rainfall further inland depends on a depression being centred over the land, at least in the upper levels of the atmosphere, and this is a less frequent occurrence. However, the worst floods on

TABLE 5
HIGH 24-HOUR RAINFALLS

Station	Number of 24-hour rainfalls over 3" in 20 years 1947-66	Highest 24-hour rainfall on record (inches)	Month of occurrence of record fall
Bonang	10	4.83	December
Buchan	6	8.45	July
Butchers Ridge	9	9.84	December
Cabbage Tree	16	6.86	January
Club Terrace	11	8.83	October
Delegate River	3	4.50	September
Dellicknora	4	5.00	January
Gabo Island	8	6.64	May
Gelantipy E.	5	4.50	September
Lakes Entrance	7	5.07	May
Nowa Nowa	12	7.78	January
Orbost	7	7.13	December
Brodrigg River	9	6.90	March
Sardine Creek	11	4.54	October
Melbourne	3	4.25	January

the Snowy River occur when heavy rain falls over most of the catchment, which extends well into New South Wales.

One of the highest floods on the Snowy occurred in January 1934, when the river reached almost twice the critical height of 17 ft at Orbost and both the bridges at McKillop and Orbost were washed away. Flooding on the Snowy occurs on an average of once or twice a year, and this river can also rise rapidly, e.g. a rise from 3 ft to 23 ft can occur in 24 hours.

Hail and Snow

In southern Victoria, hail is frequently associated with an outbreak of cold southerly air in winter and spring, but it is then usually of small size and does little damage. In summer, the intense convective activity of thunderstorms may produce large and damaging hailstorms.

Because of its local nature, (one hailstorm does not extend for more than a few miles), reliable statistics are difficult to obtain. Orbost has recorded hail on 8 occasions in 10 years, 7 of these being in the winter and spring months. Bendoc in the highlands had recorded hail on 3 occasions in 2 years.

Snow is a rare occurrence over the lower country. It has never been recorded at Orbost, although it has fallen several times at Cann River. Snow falls fairly frequently in winter at elevations over 2000 ft. Bendoc (elevation 2750 ft) has recorded snow 16 times in 2 years, and twice it has fallen as late as October. The mountains, such as the Cobberas (elevation over 6000 ft), would be snow-covered for the winter months.

Temperature

Gabo Island is typical of the equable climate near the coast, the difference between the average maximum and average minimum temperature being only about 10°F in each month of the year. (Table 6). However, even at this island location, century temperatures have been recorded in the summer months, and the temperature has fallen to freezing point in winter.

TABLE 6
AVERAGE AND EXTREME TEMPERATURES (°F)

Station	Altitude (feet)	Data	No. of year of record	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Gabo Island	50	Mean Max. Temp.	50	69.9	70.5	69.6	66.4	62.3	58.5	57.4	58.6	60.7	62.8	65.2	67.7
		Mean Min. Temp.	50	60.1	60.9	59.7	56.2	51.8	48.3	46.5	47.3	49.4	51.9	55.1	57.8
		Highest on record	73	102.5	102.3	101.5	89.0	84.0	83.0	80.0	80.0	85.0	93.0	95.0	101.0
		Lowest on record	73	41.0	43.0	38.0	37.0	33.0	32.0	31.0	32.0	32.0	36.0	34.0	39.0
Orbost	100	Mean Max. Temp.	26	77.3	76.1	74.4	68.5	62.9	58.6	57.9	59.9	63.8	66.8	70.1	74.2
		Mean Min. Temp.	26	54.5	55.3	53.0	48.1	44.1	40.7	39.0	40.1	42.7	46.5	49.7	52.7
		Highest on record	26	108.8	105.1	105.0	94.3	82.9	76.0	71.0	76.7	89.0	93.6	101.8	106.0
		Lowest on record	26	40.0	39.0	38.9	32.0	31.4	28.3	26.4	26.1	27.4	33.1	35.0	38.0
Nowa Nowa	200	Mean Max. Temp.	13	78.9	77.5	76.6	69.4	63.3	58.6	58.1	60.5	64.9	68.2	71.6	75.0
		Mean Min. Temp.	13	52.5	53.8	50.8	46.5	42.3	38.4	35.9	37.4	39.9	44.2	47.9	51.3
		Highest on record	19	109.2	105.8	103.0	91.0	77.0	75.5	69.7	75.0	83.4	91.2	99.6	106.5
		Lowest on record	19	36.5	38.0	36.2	28.1	28.0	23.5	23.4	24.0	25.6	31.0	33.6	38.0
Cann River	250	Mean Max. Temp.	11	78.8	77.1	74.5	69.1	62.0	57.4	56.8	58.9	64.4	67.6	71.4	75.3
		Mean Min. Temp.	11	53.6	54.3	52.3	45.8	41.7	38.4	36.3	37.5	40.8	45.4	48.4	51.9
		Highest on record	16	104.0	107.0	103.2	89.0	76.0	75.2	69.0	74.0	87.0	91.5	98.0	105.0
		Lowest on record	16	37.0	38.0	39.0	31.3	27.4	25.0	26.0	28.0	27.5	31.2	35.5	38.0

The moderating influence of the sea diminishes even only a few miles inland: at Orbost the range between average maximum and minimum temperatures is over 20°F .

The temperature regime is very similar at Nowa Nowa, Orbost and Cann River. All three stations are at elevations of 300 ft and situated 10-20 miles from the sea. The temperature at Orbost exceeds 100°F on one or two days a year on the average, and 90°F on 13 days. (For comparison, the figures for Melbourne are 4 and 19 days respectively).

Light frosts (air temperature less than 36°F) can occur at Orbost during the months April to September, with the average number of occasions per year 30. The temperature rarely falls below 30°F at Orbost, but frequently does so in winter at Nowa Nowa and Cann River.

A feature of the climate of this area is the mild temperatures which can occur on winter days. When northerly winds are blowing over eastern Victoria, particularly if they are bringing rain to the north-east highlands, the dry air descending from the mountains becomes quite warm. This Föhn effect, although not so pronounced as that observed in the European Alps or the Rockies, does cause the temperature to rise to the high sixties or even over seventy degrees. It is not uncommon for this area to have the highest temperatures in the State on these occasions (Fig. 4). Even Gabo Island receives this effect at times, and the temperature has reached 80° there in each of the winter months.

Bendoc, the only station in the highlands, has a period of record too short for precise means to be tabulated. From records over the past four years, the average maximum temperature is in the low seventies in January and the high forties in July. The highest temperature so far recorded is only 92° . The average minimum

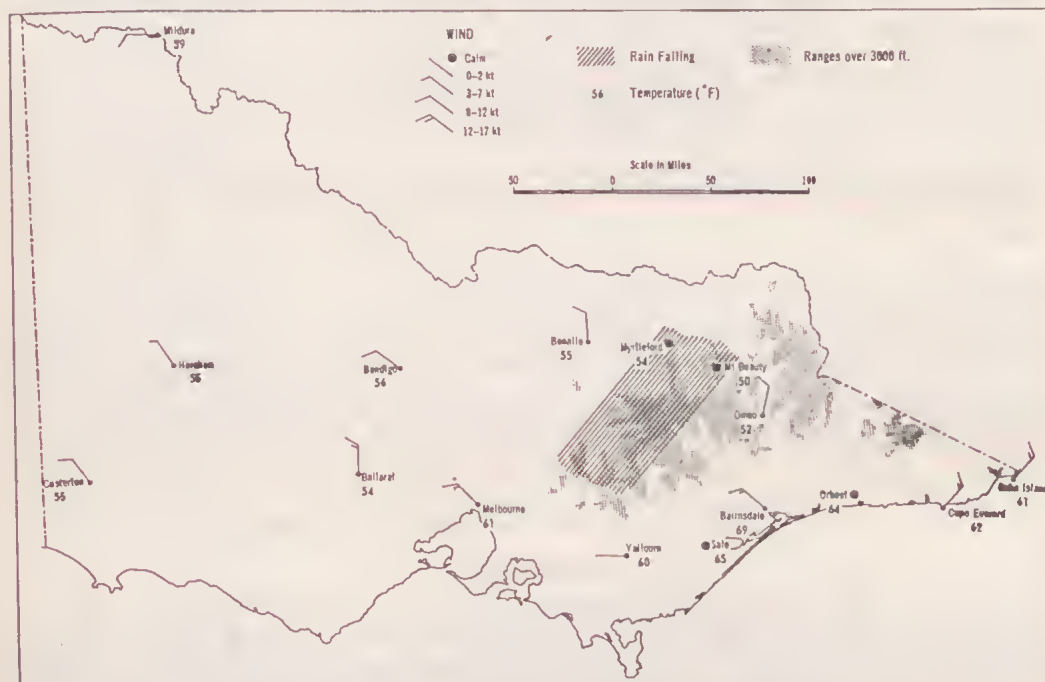


FIG. 4—Föhn Effect in East Gippsland—3 p.m. 1 July 1966.

temperature is in the mid-forties in January and below 30° in July. The lowest temperature so far recorded is 16°. Frosts can occur at almost any time of the year, the period with the temperature remaining over 36° being only 2 to 4 weeks, but it remains over 32° for 3½ to 4 months.

Fog

Fog in most of Victoria is usually due to nocturnal radiation, is more common in the colder months of the year, and occurs at night or in the early morning. However fog along the Victorian coast is usually of an advective nature, e.g. when warm moist air moved over colder water.

This happens in the summer months when a northeasterly airstream brings air from the Tasman Sea over Bass Strait, and sea fog occurs off the East Gippsland coast. The coast itself is not always affected and the average number of days of fog at Gabo Island is only two per year, distributed from October to February (Loewe 1944).

At Orbost the average number of days per year is 10, distributed through all months of the year.

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